Maine Ocean Acidification Meeting
9:00 am - 4:30 pm on January 16, 2014
Governor Hill Mansion, 136 State St., Augusta
Hosted by the Island Institute with support from the Maine Outdoor Heritage Fund, Maine Sea Grant, Maine Coastal Program, and Sustainable Fisheries Partnership

NOTES FROM PRESENTATIONS:

Shallin Busch (NOAA; member of WA state Blue Ribbon Panel on OA)- Intro to OA

- Refer to "20 Facts about Ocean Acidification" at http://www.us-ocb.org/publications/OA20Facts.pdf

Joe Salisbury (UNH Coastal Carbon group)- "Processes affecting Ocean Acidification in the coastal Gulf of Maine"

- key terms to know:
  -**pH**= hydrogen ion concentration (when temp goes up, pH goes up (at a given pCO_2)- this is good for shellbuilding organisms; when CO_2 goes up, pH goes down- not good
  -***p*CO_2**= partial pressure of CO_2 (uatm) (when pCO_2 goes up, pH goes down; when temp goes up, pCO_2 goes up)
  -**Omega (Ω)**= saturation index of the mineral aragonite
    - $\Omega>1$ animals can make shell
    - $\Omega>>1$ easier to make shell
    - $\Omega<1$ shell dissolves
    - *Ω1.6 may be a threshold for optimal larval growth of clams and oysters (Barton et al 2012, Salisbury)
- in the western GoM, pH is closely related to pCO_2
- pH is actually very hard to measure accurately
- **How to measure omega in seawater**- need 2 of these parameters: TCO_2, pCO_2 (can get at accurately), pH, TA (total alkalinity- can get at accurately) plus temp and salinity
- **Monitoring efforts to date-** a CO_2 buoy in S. Maine off of Appledore Island since 2006 and pH sensor since 2010; omega aragonite is then calculated at UNH Coastal Marine Lab
- **Factors that make the GoM sensitive-** cold, fresh, the fresh component is poorly buffered (Wang et al. 2013) because the waters coming off of our watersheds are acidic (pH 6 or below), strong seasonal productivity and mixed layer dynamics
- human activities fertilize the coastal ocean and increase the acidity
- the coastal GoM is highly productive and thus both the surface and bottom waters interact with the atmosphere over the course of a year; the surface pCO_2 is inversely linked to the bottom water pCO_2- during the growing season, surface waters have low CO_2 and bottom waters have high CO_2, but during the mixing season- that high CO_2 water comes to the surface
- *a larval marine organism at the surface of the GoM that recruits to the sea floor is sinking into very different, high pCO_2 conditions- it would be exposed to huge variability- we don't know if this inverse correlation is different now than in the past, but it is important to think about thresholds when thinking about what organisms can withstand- settling larvae in the wGoM can experience a huge range in pCO_2- a range similar to over 100 years of acidification form increasing atm pCO_2*
- **Observed trends in the GoM**- pH is down, CO_2 is up, but omega is also going up (likely because of such warm sea surface temperatures- a +0.2°C/yr)

Joe Payne (Friends of Casco Bay)- Testing pH on Clam Flats

- FOCB is concerned about coastal acidification- due to nitrogen- organic content rotting
- measuring: water pH and temp, sediment pH, sediment ORP, sediment % carbon and nitrogen and sediment surface area
- in 2012, they switched to using same pH meter as Mark Green; very focused on calibration, cleaning, etc
- sending sediment samples to Larry Mayer
- productive flats always had higher pH
- found pH values as low as 6.4 in sediments; Mark Green found complete dissolution at 6.8
- DNA study of nitrifying bacteria underway (Dan Brizow at UNE)

Mark Green (St. Joseph's College; Peaks Island Shellfish Co.)- Consequences of ocean acidification from North American early life stage bivalves

- OA is already happening- today is not the baseline- the baseline is 150 years ago
- if ocean acidification is "the other CO_2 problem" then coastal ocean acidification is "the other eutrophication problem"
- coastal acidification because of eutrophication is happening faster than ocean acidification
- today's coastal oceans are exposed to multiple stressors- warmer, more acidic, and lower in oxygen
- OA impacts on hard calms, eastern oysters, bay scallops- increased mortality (death by dissolution), delayed onset of metamorphosis, slower growth, and depressed Ca^{2+} uptake
- juvenile clams- made of more soluble form of calcium carbonate (aragonite) than adults
- bay scallops- 5 week survival- calcification rate is half of what it would have been 100 years ago

Bill Mook (Mook Sea Farm)- Concerns about Climate Change and Ocean Acidification in a Maine Oyster Hatchery

- been in business for 29; company founded in 1985; located on Damariscotta River
- supplies post set oyster seed to other east coast growers and market sized oysters to the US half shell market
- the hatchery is the engine of the business
- during ~ 14 day free-swimming larval phase, oyster larvae are building thin, fragile shells from the most soluble form of calcium carbonate; during this phase, hatchery water change occurs every 48 hours
- every water change is a bioassay- feeding, growth, and survival are determined by water quality
- reduced feeding, growth, and sometimes survival after large runoff events
- they don't have don't have adequate monitoring capability, so can't say for sure if this is linked to acidification, but they do see low pH during these events
- in the next year, they are hoping to generate more information using Joe Salisbury's sensors
- **Financial impacts-** 2 storms each adding 1 week to the larval phase equals the loss of one spawn, which is over $100,000 in lost seed sales
- another reason for concern- during the first 48 hours, larvae are especially vulnerable to water quality because they are forming a new shell; occasionally, they've seen failed or very poor conversion from fertilized egg to straight hinge larvae and/or a high proportion of shell

deformities in new spawns. Clear cases of this have not occurred since heightened awareness of the potential for acidification effects

- need to increase monitoring capability
- **Precautionary management steps-** storing water ahead of rainfall events and doing some pH adjustments
- Hatcheries can be a useful tool:
  -testing different management techniques
  -understanding impacts on other shellfish species
  -selective breeding for acidification tolerant strains
  -augmenting wild fisheries
  -need to be part of a statewide effort to understand and cope with OA

Curt Brown (GMRI; Lobsterman)- Lobsters and Ocean Acidification

- hard to believe the lack of knowledge about impacts of OA in Maine, especially considering the economic importance- ***"Our understanding of OA is woefully inadequate for such an important species."***
- Maine has 4500 active commercial lobstermen, 1500 clammers, and 1500 other fishermen, so with pH declining, we are going to have a big problem
- lobstermen in Maine don't have anywhere to go- need to figure out the impacts
- OA is not happening in a vacuum; combined with temp rise- seeing more warmer water species including trigger fish, tautog, black sea bass
- how will OA impact shell disease?
- can impacts of OA be mediated by a more calcium rich diet (crabs)?
- lobstermen aren't talking about OA on the VHF radio, they are more concerned with the low price; but it is in the back of people's minds

Mick Devin (Maine State Representative)- Update on Maine OA bill

- the bill would establish an expert commission to address OA; but would not be funded to collect data
- initially the legislative council was tepid about the bill, but Devin successfully appealed the bill in November
- at the public hearing in January, there was overwhelming support- 19 were for the bill (including commissioner of DMR); 1 neither for nor against
- the bill will be debated by the full legislature in the upcoming weeks

Jay Manning (Cascadia Law Group; Co-chair of WA Blue Ribbon Panel on OA)- Lessons from WA State

- Washington's waters are at risk to ocean acidification because highly acidic seawater upwells off the coast and enclosed bays are slow to flush upwelled acidic seawater and are exacerbated by land-based sources of acidifying pollution
- WA is the country's leading producer of clams and oysters, growing 85% of commercial shellfish; an annual value of $270 million and 3,200 jobs
- between 2005 and 2009, WA and OR shellfish hatcheries suffered disastrous production losses due to acidity
- in February 2012, Gov. Chris Gregoire created a Blue Ribbon Panel on OA to describe what we know, what we don't, and what we should do about it; **WA BRP had 28 members- 7 scientists, 4**

legislators, 2 county commissioners, 3 agency heads, 2 tribal reps, 1 member of Congress, and business stakeholders

- **WA BRP produced two reports- one on science of OA in WA & one on a strategic response which recommends 42 different actions to respond to the threat of OA**
- See the recommendations and "key early actions" starting on p. 27 at: https://fortress.wa.gov/ecy/publications/publications/1201015.pdf
- in November 2012, the BRP presented the report and recommendations to the Governor and in response, the Governor issued an executive order implementing 12 of the key early actions
- Legislative action included: $3.31 in proposed 2013-2015 budget; funds appropriated for new WA OA Center at UW and other research and monitoring recommendations; Senate bill creates a Marine Resources Advisory Council operating out of the Gov's office, charged with maintaining focus and momentum on OA

Cassie Stymiest (NE-CAN)- Regional efforts from the Northeast Coastal Acidification Network

- NE-CAN is a nexus of scientists, federal and state agency reps, resource managers, and affected industry partners that serves as an interface between research and industry interests; we are all part of NE-CAN
- hosting webinar series on OA science from November to March, followed by a meeting in April to synthesize the state of the science
- plans to hold stakeholder meetings in summer and fall

Dwight Gledhill (NOAA)- National Efforts from NOAA

- NOAA's new Ocean Acidification Program Office is tiny (5 people), but mighty (>55 projects and activities engaged by NOAA, Regional Partners, and Academic Researchers)
- established under the Federal Ocean Acidification Research and Monitoring (FOARAM) Act of 2009 to coordinate research, monitoring, and other activities consistent with the strategic research and implementation plan developed by the interagency working group on OA (NOAA, NSF, NASA, USGS, FWS, EPA, BOEM, DOS)
- important to have coordinated strategy to make the most of little funds
- 50% of money goes out to academic partners
- NOAA OA program office funds more coastal programs
- NOAA climate program office funds more open ocean programs

Curtis Bohlen (Casco Bay Estuary Partnership)- Introduction to Mitigation and Adaptation

- we are at the beginning of a long period of change due to acidification, climate change, coastal development, declining fish stocks, and invasive species
- how do we plan if the past is not longer a good guide to the future?
- our choices are: prevent or avoid change, reduce magnitude of change, reduce impact of change, adapt to change, and accept change
- build resilience in marine ecosystems (structural complexity), fisheries & the maritime economy (diversification & flexibility), and coastal communities (communication, politics)

Darcie Couture (Resource Access International)- Buffering Treatments on "Dead Mud"

- what can towns realistically do to improve shellfish habitat?

- a small study in Freeport determined that towns can apply pulverized shell hash which may effectively buffer dead mud and improve chances for shellfish recruitment
- future work needed with larger study area, multiple replicates and longer duration

Dwight Gledhill (NOAA)- Ocean Acidification Refugia

- **refugia= a system, by virtue of it's natural environmental setting, that may resist/delay the chemical changes of OA**
- the governing processes controlling local carbonate chemistry could offer benefit to otherwise sensitive organisms
- refugia are limited in space and often time (at the daily and seasonal scale)
- such systems should be identified, promoted, and preferentially protected
- if you can favor photosynthesis over respiration, you'll enhance pH- which strategies of coastal land-use practices and coastal runoff management promote P>R?
- example of the Florida Keys Reef Tract- best coral cover in inner reef tract (where there is a lot of sea grass)
- **we need more comprehensive observing capabilities to identify and monitor regionally relevant refugia**
- how can we better protect known refugia (e.g. seagrass, kelp, and other macroalgae)?

Brad Warren (Global Ocean Health, a joint in initiative of Sustainable Fisheries Partnership and National Fisheries Conservation Center)- OA Adaptation in Shellfish Production & Cooperative Nutrient Solutions

- **Pacific oyster industry first to be hit and know it- 60-80% loss of production in 2007-2008** and little to no commercial-scale wild set oysters in Willapa Bay 2005-2012
- monitoring and research is important in order to know what's coming and prepare
- **in WA, the oyster industry, fishing industry, fishing tribes drove the response to OA**
- so far, only proven form of adaptation is limited to oyster hatcheries- filling larval tanks in the afternoon or during the night
- cooperative mitigation example- dairy methane and nutrient runoff
- a biodigester helps reduce CO_2 emissions and nutrient waste- one dairy farm family has saved $250K on waste hauling and earns extra $ from generated power